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The validity of clinical examination in screening of developmental dysplasia of the hip among infants aged less than six months

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Abstract

Background and objectives: Developmental dysplasia of the hip is a challenging condition, requiring screening for early diagnosis. This study was conducted to assess the validity of clinical screening tests of developmental dysplasia of the hip among infants aged less than 6 months. **Methods:** A cross-sectional study conducted at the center of early detection of childhood disability, Duhok City, Iraq for the period from April 2018 to February 2019. A convenience sample of 100 infants aged less than 6 months, who were referred to orthopedic surgeon in this center were included. Three clinical examination tests were conducted followed by ultrasonography of the hip joints **Results:** Out of 100 infants, 59 (59%) were detected by ultrasonography to have Developmental Dysplasia of the Hip; 39% had unilateral and 20% bilateral ones. Barlow test was found to have the highest sensitivity, 49.15%, with a specificity of 85.37%, positive predictive value was 82.86%, and negative predictive value was 53.85%, compared to that of Ortolani test: 30.51%, 82.93%, 72.0%, and 45.33%, respectively. Galeazzi test reported to have the lowest sensitivity (8.47%), with both specificity and positive predictive value of 100%, and negative predictive value of 43.15%. Female gender was significantly associated with Developmental Dysplasia of the Hip in infants, with female to male ratio of 1.6:1. **Conclusions:** Barlow test is the clinical test of the highest sensitivity and good specificity for the screening of infant Developmental Dysplasia of the Hip. Because of the high false negative results of the three clinical screening tests, further assessment with ultrasound is recommended

Key words: Barlow test, Developmental Dysplasia of the Hip,Galeazzi test,Ortolani test.

Introduction

Developmental dyplasia of the hip joint (DDH), previously known as Congenital Dysplasia of the Hip (CDH), reflects many abnormalities of the hip joint, including a mild form of dysplasia of the acetabulum to irreversible reduction of the femoral head[1]. This musculoskeletal disorder leads to long term morbidities, including gait abnormalities, degenerative arthritis and chronic pain that will need a total hip replacement in the future if left untreated[2,3]. Multifactorial - biomechanical intrauterine causes, such as breech presentation and oligohydraminos, and family history of DDH are risk factors for developing DDH in newborns, and swaddling might increase the risk of DDH in infancy. The incidence varies from one region to another depending on the age of presentation and the facilities available to detect DDH in early infancy, ranging from 2.7/1000 in Taiwan[4] to 3.7/1000 in Saudi Arabia, with a female to male ratio of 2.6:1[5]. Many European countries start to screen newborns for DDH by ultrasound as a standard rule at birth for early detection of DDH and mark those susceptible for early follow-up by pediatrician or pediatric orthopedics[6]. Screening of DDH varies from history taking and clinical examination to more sophisticated investigations including ultrasound, examination under general anesthesia to Intra-articular injection of contrast to assess the hip joint and the position of the labrum and the cartilaginous femoral head[7]. Clinical examinations of the hip joint to detect DDH are done by Ortolani test and Barlow Maneuver. Ortolani test is a relocation maneuver conducted by gently manipulating the flexed hip from adduction to abduction to bring the femoral head anteriorly back into the acetabulum from a dislocated position. Barlow maneuver is a provocation test conducted by adducting the flexed hip and applying gentle anterior to posterior pressure in order to push the femoral

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head superior and posterior over the edge of a shallow acetabulum. These maneuvers are best performed with the clinician's palms over the infant's knees and the middle fingertip placed over the greater trochanter, Figure 1.

At a later stage, clinical examination findings may include asymmetrical skin folds, the leg-length discrepancy with a shorter affected limb denoting a positive Galeazzi test and reduced range of abduction, Figure 2. Bilateral DDH is always more difficult to diagnose as symmetrical changes are more difficult to pick up[8].

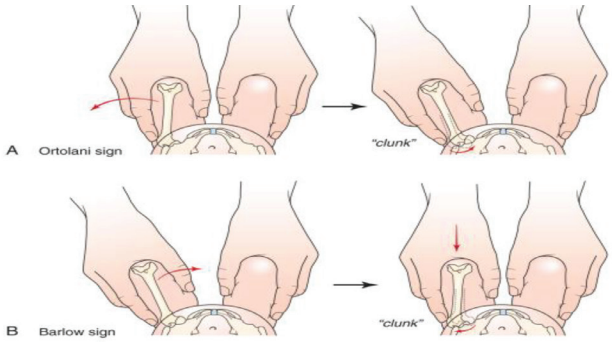

Figure (1): Maneuvers of Ortolani and Barlow clinical examination

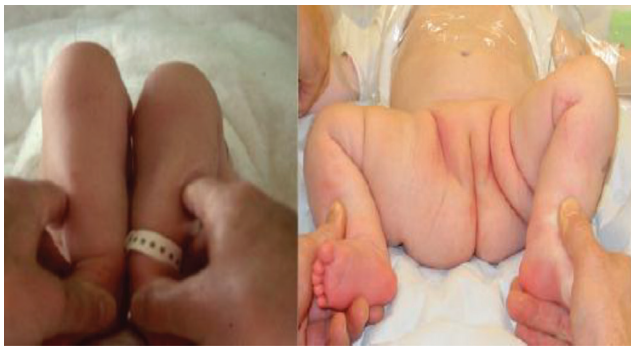

Figure (2): Maneuver of Galeazzi test in clinical examination of DDH

There is fair evidence to include specific clinical examination tests of the hips by a trained clinician in the periodic health examination of all infants until they are walking. Assessment of the validity of these tests could help in determining how far these tests could be trusted as a screening tool of DDH. Our study aimed at assessing the validity of the clinical examination tests in the screening of DDH among infants aged less than six months, and identifying the association of specific risk factors with infant DDH.

Subjects and methods

A cross-sectional study was conducted at the center of early detection of childhood disability and Hevi Pediatric Hospital in Duhok City, Iraq for the period from April 2018 to February 2019.

A convenience sample of 100 infants aged less than 6 months, who were referred to the center of early detection of childhood disability during the study period and were suspected to have DDH, were included in this study. Infants with neurological impairment and severe congenital disability were excluded. A structured questionnaire had been prepared by the researcher and completed throughout a direct interview with the parents of the enrolled infants. The first part included information related to the age, gender, mode of delivery (whether normal vaginal delivery or Cesarean section), birth weight and other risk factors including prematurity, history of oligohydraminos, family history of DDH, and the use of cradle or swaddle. The second part covered the results of both the clinical examination, conducted by two orthopedic surgeons, and the ultrasonography. All the recruited infants were examined clinically by expert orthopedician, who applied three clinical examination tests used for early detection of DDH, including Ortolani, Barlow's maneuver, and Galeazzi sign. The infants were classified either to have normal hip joint, or unilateral or bilateral hip joint abnormality. All the examined infants were then referred to the ultrasound unit in the same center or in Hevi Pediatric Hospital, where an ultrasonography of both hip joints was performed, and the final diagnosis of unilateral or bilateral abnormality (whether dysplasia or dislocation) was confirmed. The ultrasonography was used as a gold standard test in detecting infant DDH, and then accordingly, the validity of the three screening tests of infant DDH applied in this study was assessed. The validity tests included the following: sensitivity test, specificity test, positive predictive value test and negative predictive value test.

The approval of the research protocol by the scientific and ethics committees at Kurdistan Board of Medical Specialties had been achieved. Participation was voluntary and the parents were assured that all the utilized information would be confidential, and a written consent was obtained from all the participating parents. Data were analyzed using the Statistical Package for Social Sciences (SPSS, version 22) and presented as frequency and percent distributions. Chi-square test of association was used to compare proportions. Fisher's exact test was used when

the expected count of more than 20% of the cells of the table was less than 5. A p-value of ≤ 0.05 was considered statistically significant. Specificity, sensitivity, positive predictive value, and negative predictive values had been calculated for the studied screening tests.

Results

One hundred infants aged less than 6 months were included in this study, of whom 58 (58%) were females. The mean age ± SD of the studied sample was 3.38 ± 1.48 months, and their birth weight was found to be within the normal range (2.5-4kg).

Figure 3 shows that 39% of the studied infants were detected to have unilateral DDH and 20% had bilateral DDH as confirmed by ultrasonography. The clinical screening tests applied for them reported as following: 27% unilateral and 8% bilateral DDH by Barlow test, 21% unilateral and 4% bilateral DDH by Ortolani test, and only 5% unilateral DDH could be detected by Galeazzi test.

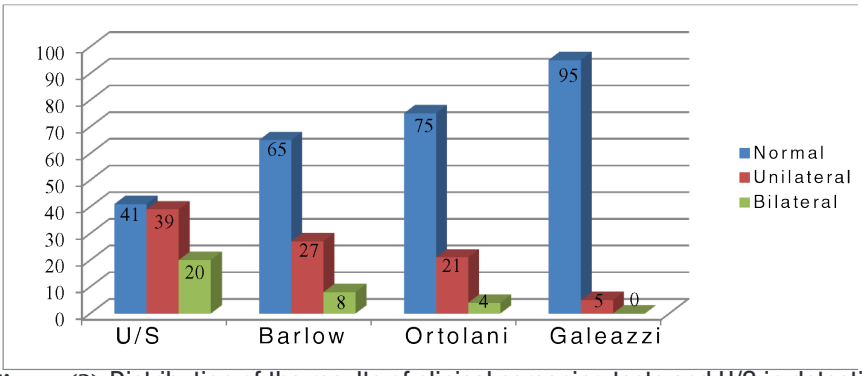

Figure (3): Distribution of the results of clinical screening tests and U/S in detecting DDH of hip joints in infants aged ≤6 months.

Table 1 shows that the only risk factor that was found to be significantly associated with DDH in infants aged ≤6 months was gender (p-value =0.005). It was diagnosed in 70.69% of female infants compared to 42.86% among male infants, with a female to male ratio of 1.6:1. No statistically significant associations were found between DDH among the studied infants and other risk factors including age distribution (p-value =642), mode of delivery (p-value = 0.210), prematurity (p-value = 0.523), oligohydraminos (p-value = 0.34), family history of DDH (p-value = 0.136), and the use of cradle or swaddle (p-value = 0.912).

Table (1): DDH among infants aged ≤ 6 months in relation to specific risk factors.

Risk Factor		Normal		Hip Dysplasia		Total		p-value
		No.	%	No.	%	No.	%	
Gender	Male	24	57.14%	18	42.86%	42	42%	0.005
	Female	17	29.31%	41	70.69%	58	58%	
Age	≤3m	21	38.89%	33	61.11%	54	54%	0.642
	>3m	20	43.47	26	56.53%	46	46%	
Mode of Delivery	NVD	19	48.71%	20	51.29%	39	39%	0.210
	C/S	22	36.06%	39	73.94%	61	61%	
Prematurity	<37w	39	41.48%	55	58.52%	94	94%	0.523
	≥37w	2	33.33%	4	66.66%	6	6%	
Oligohydraminos	-ve	32	48.48%	34	51.52%	66	66%	0.34
	+ve	9	26.47%	25	73.53%	34	34%	
Family Hx Of DDH	-ve	27	47.36%	30	52.64%	57	57%	0.136
	+ve	14	32.55%	29	67.45%	43	43%	
Use of cradle or swaddle	-ve	19	40.42%	28	59.58%	47	47%	0.912
	+ve	22	41.50%	31	58.50%	53	53%	

Table 2 presents the true positive, true negative, false positive and false negative results of the three screening tests, used to detect DDH among the studied infants, compared with the results of ultrasonography of their hip joints.

Table (2): The true and false results of screening tests of DDH of infants aged ≤6 months compared with the results of U/S.

Clinical test	Total +ve	True +ve	False +ve	Total -ve	True -ve	False -ve
Barlow	35	29	6	65	35	30
Ortolani	25	18	7	75	34	41
Galeazzi	5	5	0	95	41	54

Table 3 shows that the Barlow test was the screening test with the highest sensitivity of 49.15%, with specificity of 85.37%, positive predictive value 82.86%, and negative predictive value of 53.85%, compared to Ortolani test which was found to have much lower sensitivity of 30.51%, yet nearly similar specificity (82.93%) with positive predictive value of 72.0% and negative predictive value of 45.33%. However, Galeazzi test was found to have the lowest sensitivity (8.47%), and highest specificity (100%) and positive predictive value (100%), with a negative predictive value of 43.15%.

Table (3): The validity of the clinical screening tests in the detection of DDH in infants aged ≤6 months.

Clinical test	Sensitivity	Specificity	positive predictive value	negative predictive value
Barlow	49.15	85.37	82.86	53.85
Ortolani	30.51	82.93	72.0	45.33
Galeazzi	8.47	100	100	43.15

Discussion

Developmental dysplasia of the hip joint is a common and significant health problem. Early diagnosis and treatment of this developmental defect will probably decrease the need for surgical interventions with much better outcomes[9], since any delay in the diagnosis may lead to increased severity, costs and complexity of procedures required for its treatment[10]. In this study, 59% of the enrolled infants was found to have DDH, 39% with unilateral and 20% with bilateral abnormality, whether dysplasia or dislocation of the hip joint.

Several strategies have been developed for screening of DDH in infants at their first months of life including clinical examination, which till now is considered the standard screening test in most countries[10], including Kurdistan Region, Iraq. In this study, the validity of three clinical screening tests, applied for detection of DDH, among infants less than 6 months of age were assessed: Barlow, Ortolani and Galeazzi tests.

Among these three tests, Barlow test was found to have the highest sensitivity (49.15%) with good specificity (85.37%). These results were consistent with that of a study conducted by Grubor et al.[11] in which Barlow test was found to have a sensitivity of 42.11% and a good specificity (84.9%). However, a study done by Akgun et al.9 reported a lower sensitivity (38.5%) and concluded that regardless of how skilled the examiner is, the sensitivity of clinical examination is still limited.

Regarding the age at which Barlow test is conducted would affect its validity in screening for DDH, a study conducted by Jackson et al.[12] included infants older than 3 months and concluded that Barlow test had a sensitivity and specificity of (69%) and (54%), respectively[12]. Another study conducted by Mace et al.[13] revealed that clinical

examination during the neonatal period had a rather high sensitivity (62%) and a specificity of 99.8% with a high false positive result and a very low positive predictive value of 24%. Compared to our study, which involved both infants in the neonatal period and older infants of less than 6 months of age, Barlow test yielded a low false positive and high positive predictive value (82.86%), which was also higher than what is reported by Grubor et al11 (36.36%). Barlow test (abduction test) in this study could be regarded more valid in detecting infant DDH than Ortolani test, with sensitivity of 49.15% vs. 30.51%, respectively, and specificity of 85.37% vs. 82.93%, respectively.

According to Sewell & Eastwood,[14] when the limitation of abduction (i.e. positive Barlow test) is bilateral, it is not such a useful clinical indicator of underlying hip joint abnormality; however, when it is unilateral, it is much more sensitive than Ortolani maneuver. In this study, Barlow test reported 29% unilateral hip developmental defect.

The infants included in this study were also examined for leg length discrepancy (Galeazzi sign), which according to many studies is considered to be a more precise, sensitive, and noninvasive method to diagnose DDH[15], yet our results revealed very low sensitivity (8.47%) with high false negative, rendering it the lowest valid test.

Although clinical examination tests are not sensitive enough[14] and clinical signs are not sufficient to diagnosis DDH[11], causing some cases to be missed1, these clinical tests are considered cost effective,[10] and every infant must be examined for any sign of hip instability. Meanwhile, when infants have risk factors for DDH, examination should be performed more carefully by a skilled well-trained physician, whether working at primary, secondary or tertiary health care facilities.

Some studies suggest that training of the physician performing the maneuvers may optimize the skills needed to apply these screening tests perfectly and precisely, which could ultimately maximize their accuracy[10]. It is worth mentioning that Rosendahl et al.16 found that systematic training in clinical skills reduced the prevalence of DDH over a period of 5 years.

Although ultrasound is more accurate than physical examination in diagnosing DDH[2], the recommendations of the American Academy of Pediatrics are against universal screening for DDH with ultra¬sonography; however, it can be selectively performed in infants, six weeks to six months of age, who have normal findings on physical examination, but are considered high risk[17].

According to Apley and Solomon, ultrasound has largely replaced radiography in neonatal screening.[1] Furthermore, studies have shown a lower incidence of late-detected hip dysplasia after ultrasound screening of newborns[18]. In Austria, after the implementation of the national screening program of DDH with ultrasound, there was a decrease in the annual incidence of open reduction surgeries from 3.5/1000 to 0.16/1000 over the period of 16 years. Additionally, pelvic osteotomies and acetabuloplasty fell by 46%, and the number of hospital readmissions for DDH decreased from 9.5 to 3.6/1000 live births[10].

The only risk factor that found to be significantly associated with infant DDH in this study was gender: females were more affected than males (p-value=0.005), with a female to male ratio of 1.6:1. This is in comparison to studies conducted by Arti et al.[15] and Cenk Sezer et al.[19] that also found a statistically significant difference in diagnosing infant DDH between females and males, p-value = 0.002 and p-value = 0.0033, respectively. Furthermore, according to Bengt Kallen et al.,[20] female excess was the major demographic characteristic of infants with DDH despite the variation of DDH frequency between countries. On the other hand, this study did not reveal any significant association between DDH and other risk factors, such as prematurity and prenatal history of oligohydraminos, which was similar to the findings of a study conducted by Sezer et al.,[19] who also concluded that these risk factors were less significant in terms of their impact on the diagnosis of DDH. Caesarean section was also found to have no noticeable effect on DDH, which was consistent with a study conducted by Kallen et al.[20] Moreover, other risk factors, including family history, using the cradle or swaddling the baby, did not reveal any significant association with infant DDH in our study.

Conclusions

More than half of the high-risk infants aged less than 6 months were confirmed to have DDH by U/S. Barlow test is the clinical examination test of the highest sensitivity compared to Ortolani and Galeazzi tests in screening for DDH. Despite the good specificity of the three clinical screening tests, they cannot be depended on solely in screening for DDH because of their high false negative results; therefore, further assessment with U/S is recommended.

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